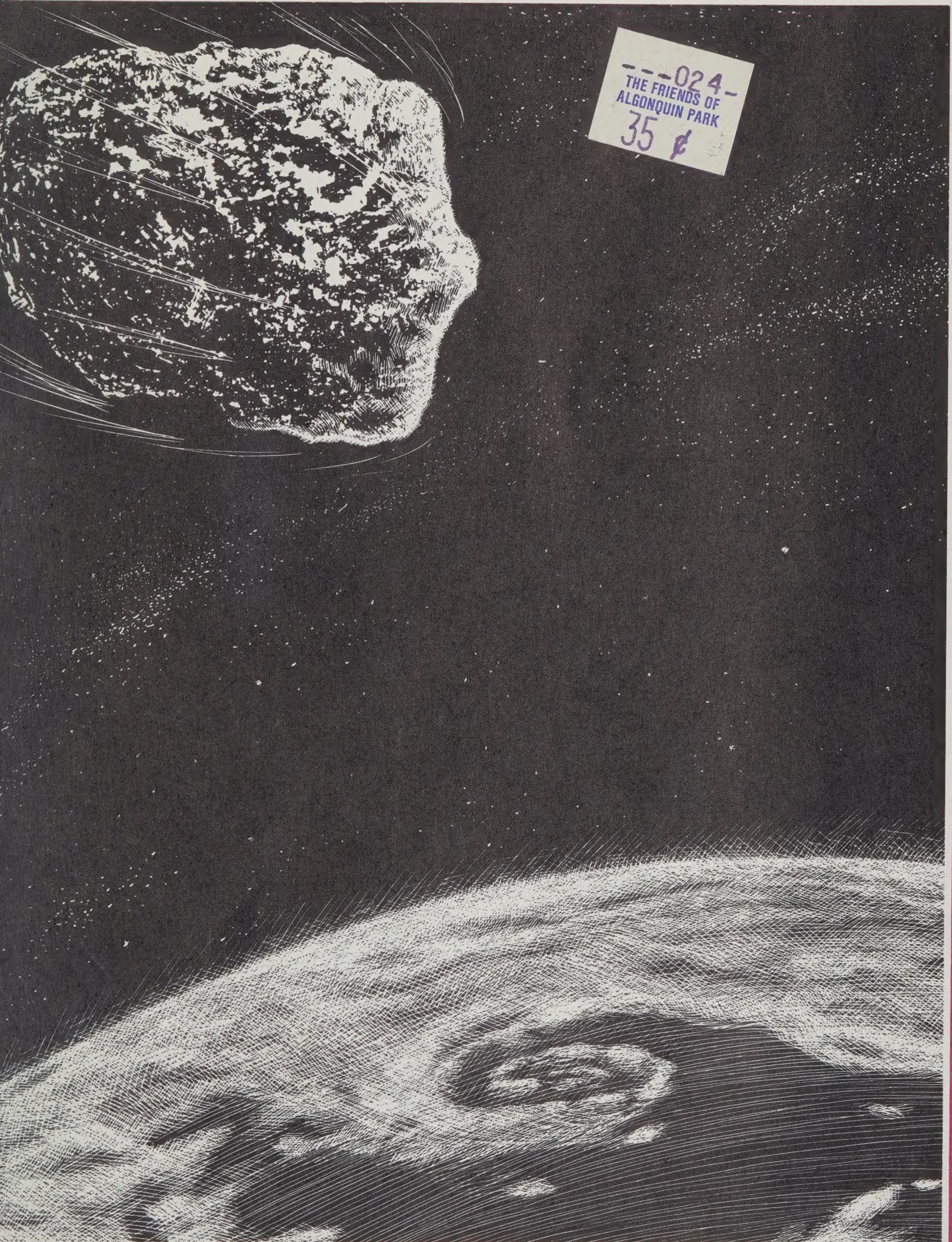
Brent Crater Trail

History of the Crater



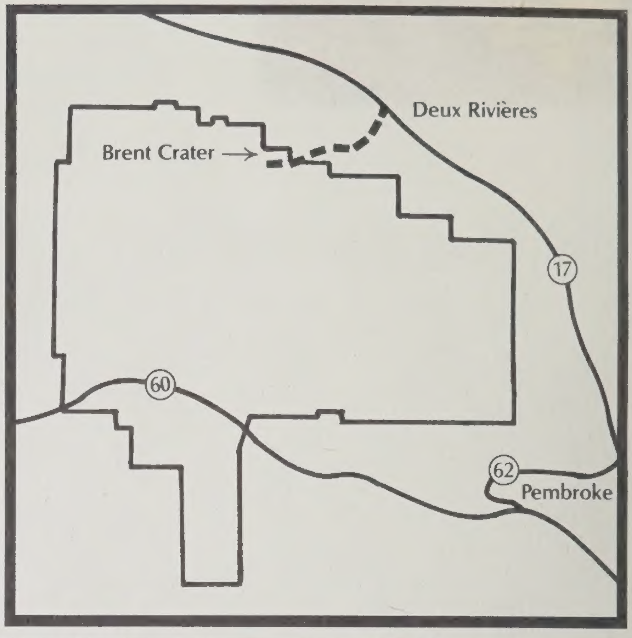
Brent Crater Trail

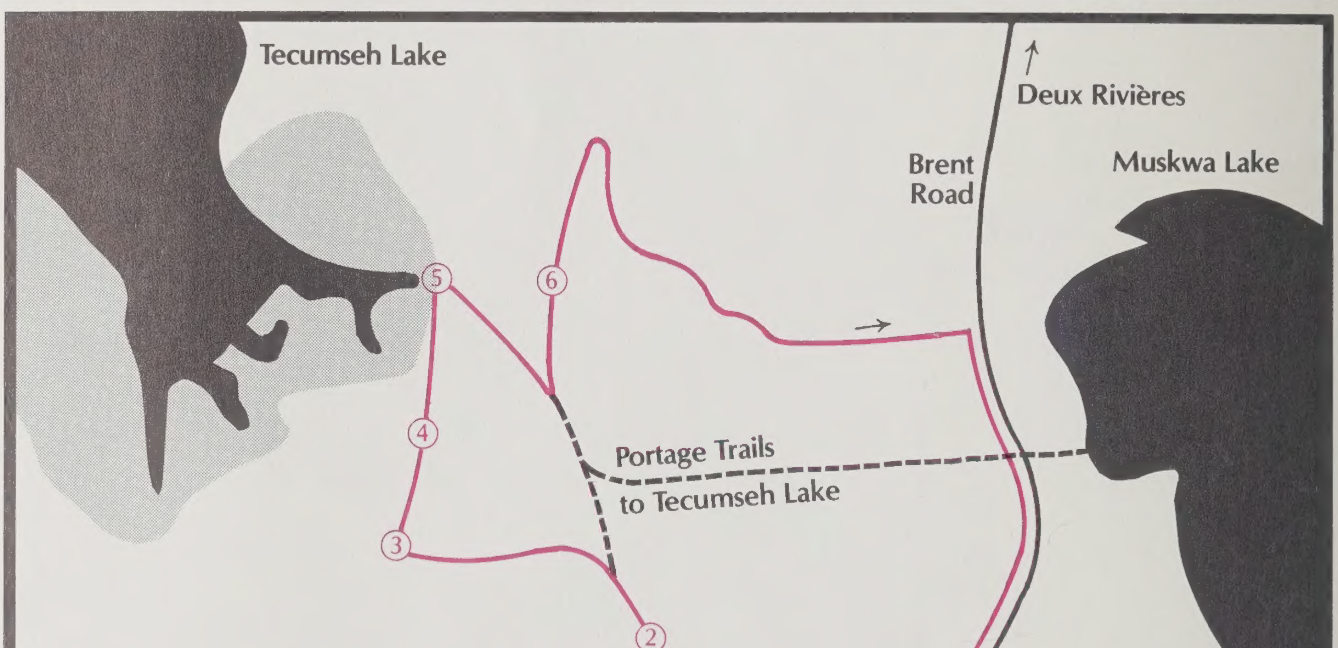
Text by Dan Strickland

Drawings by Howard Coneybeare

The Brent Crater Trail is a 2 km loop just inside the northern boundary of Algonquin Park. It leaves the Brent Road at a point 32 km south of Deux Rivières (on Highway 17 beside the Ottawa River) and 8 km north of Brent on Cedar Lake. From a wooden observation tower overlooking the crater from the crater rim, the trail descends to the present floor of the crater before looping back to the starting point.

The numbered sections of this guide, corresponding to numbered posts along the trail, relate some of the geology and significance of this spectacular feature.





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The Friends of Algonquin Park and the Ministry of Natural Resources wish to acknowledge the invaluable assistance of Dr. Michael R. Dence in the preparation of this trail guide.

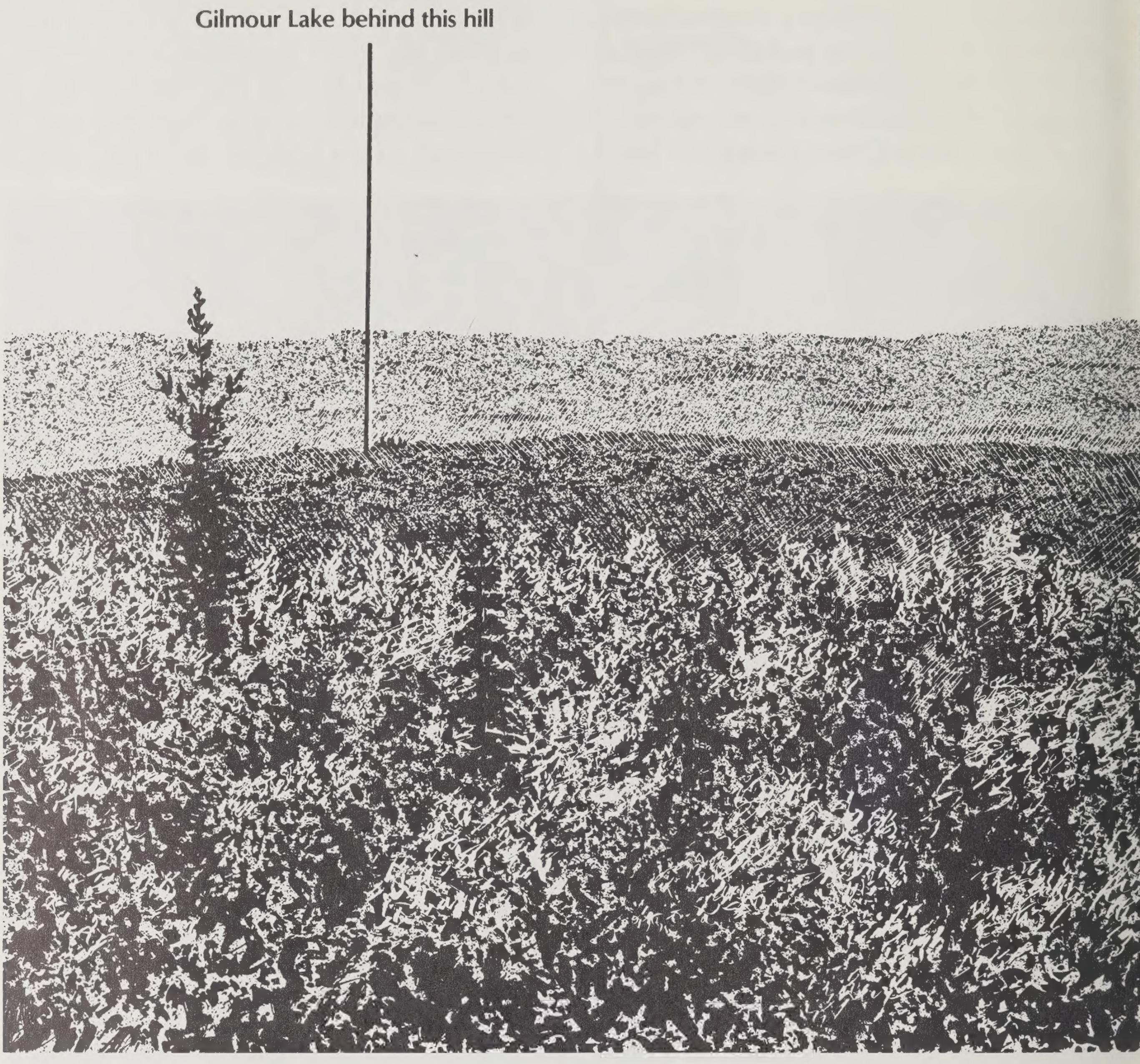
A Startling Discovery

Early in 1951, Mr. John A. Roberts, the president of Spartan Air Services Ltd. of Ottawa, was looking over some of the high altitude aerial photos his company had taken for the Government of Canada when he noticed an almost perfectly circular feature, 3 km wide, straddling the boundary of Algonquin Park north of Brent on Cedar Lake. Only the summer before, the Royal Ontario Museum had investigated a large 3.2 km wide meteorite crater in northern Quebec and had publicized the possible connection between circular markings on the Canadian Shield and ancient meteorite impacts. Spartan Air Services alerted the Dominion Observatory of Canada in

Ottawa to their discovery and the first scientific investigation into what quickly became known as the Brent Crater was conducted that very same year. Since then over 10 seasons of field work have been conducted by more than a dozen investigators and their assistants, including the diamond drilling of twelve holes and the recovery of some 5,000 metres of drill core, making the Brent Crater among the best known and most thoroughly studied fossil meteorite craters in the world.

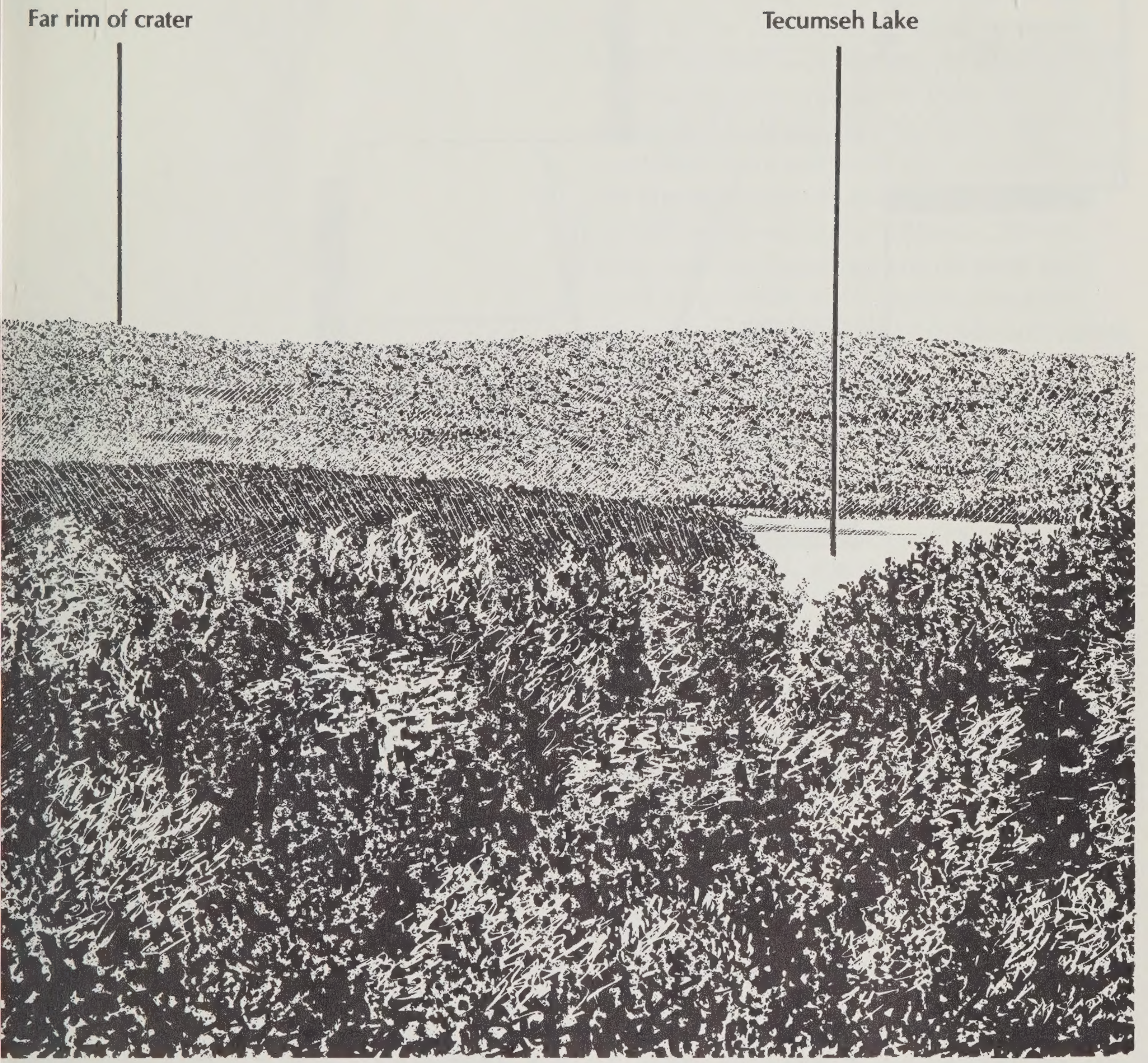
The trail and this booklet have been designed to introduce you to some of the most important features of the Crater and what they mean. To start off, we invite you to climb the tower (originally built in 1972 for a field excursion of the 24th International Geological Congress held that year in Montreal) to see how big the crater really is.

Post 1 An Awesome Hole



This tower, located on the southeast rim of the crater, gets you just high enough so that you can look out across the crater to its opposite rim, about 4 km away. You can also see part of Tecumseh Lake, the lake which now occupies the northeastern part of the present crater floor, some 100 metres below your present elevation. The other, somewhat larger lake in the crater, called Gilmour Lake, is hidden from you by a gently sloping hill in the middle of the crater. This hill is topped by sandy and gravelly material left by the melting of the last glacier about 11,000 years ago. Underneath the loose glacial material lies an almost 250 metre thickness of limestones and other sedimentary rocks deposited in the crater after it was formed. Without these sedimentary rocks the crater would now be filled with a 250 metre (800 ft.) deep lake.

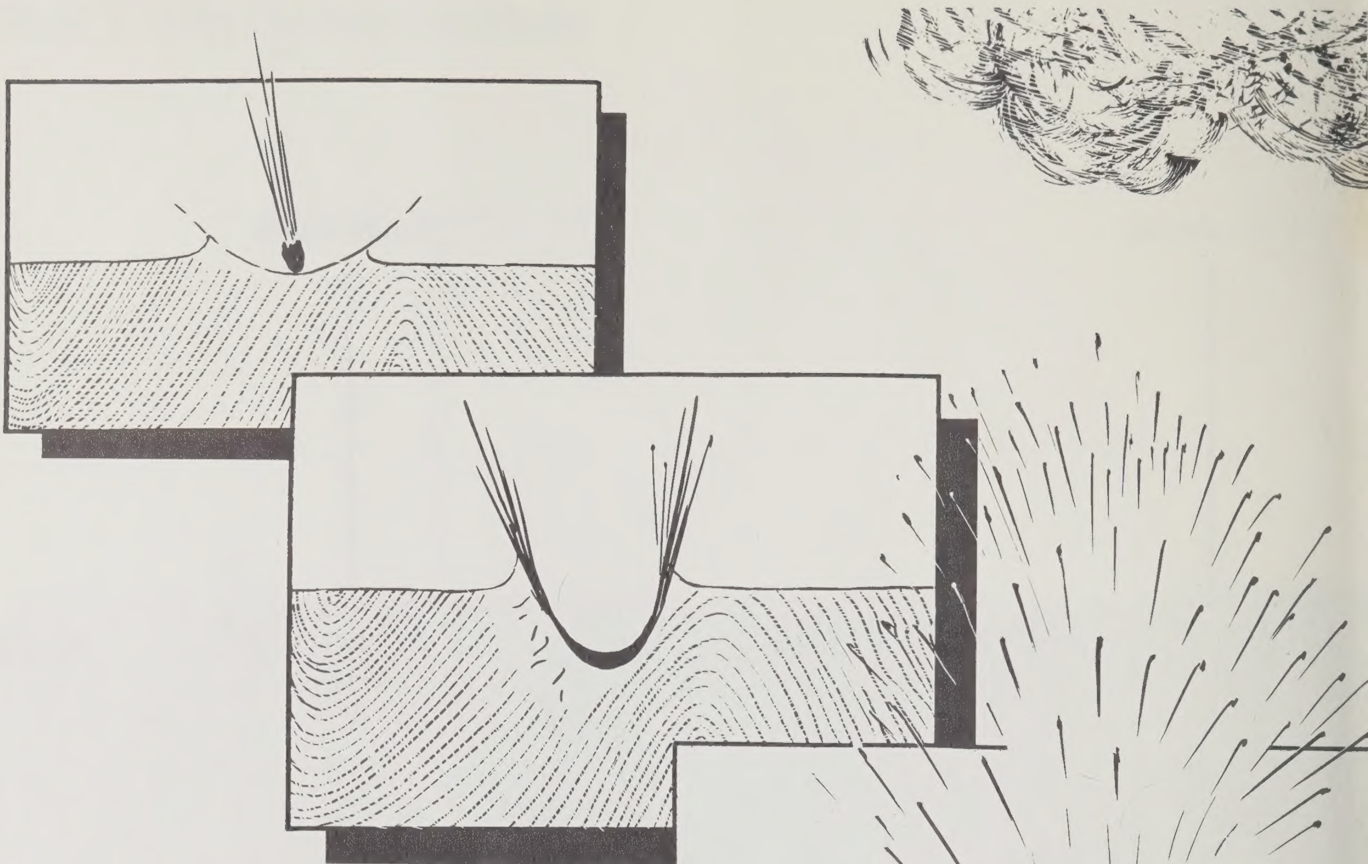
Although you cannot see from here how perfectly circular the crater is, you can certainly appreciate how big it is and how awesome the explosion which created it must have been. Even though the rim the tower is standing on has been slowly eroded down some 200 metres from its original, sharp, uplifted configuration, and even though the bottom 250 metres of the crater itself have been filled in with sedimentary rock and glacial debris, the crater is still visible. The 450 million years which

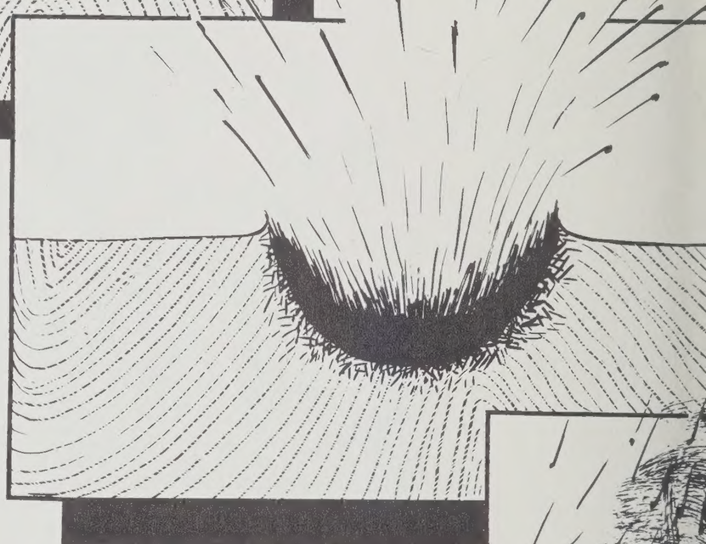


are believed to have passed since its creation have not been enough to completely obliterate it.

Elsewhere in the world the forces of erosion would have almost certainly removed all traces of such an old crater but here, in the hard, stable, granitic Canadian Shield, evidence of ancient events may be preserved for much longer. Indeed, of the over 100 fossil meteorite craters now known from around the world, fully 24 are on the relatively small Canadian shield and, of course, there is no reason to believe that the rest of the planet was really hit any less often than the Shield. As a matter of fact, the heavily cratered surface of the moon (where erosion acts extremely slowly to rub out the evidence of craters) indicates that, early in their history, the earth and the moon almost certainly were both subject to heavy bombardment by wayward asteroids and other "space junk." Most of these interplanetary hazards have been removed by earlier collisions with various planets and moons in our solar system and now, major collisions such as the one which created the Brent Crater are thought to occur only about once every 10,000 years.

To take the trail down the crater wall to its present floor, walk south along the road for 50 metres until you see the trail leading off to your right.



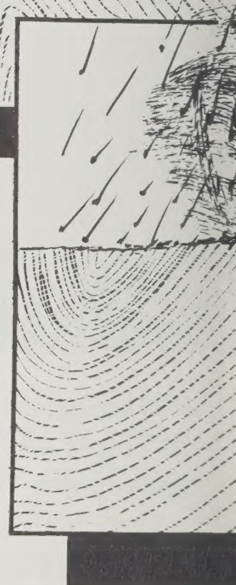


Post 2
The Evidence is Still Here

Today, the scene in these woods is quite peaceful and it is rather hard to imagine a 4 km wide hole being blasted out of the earth at this spot. Nevertheless, the evidence is still here.

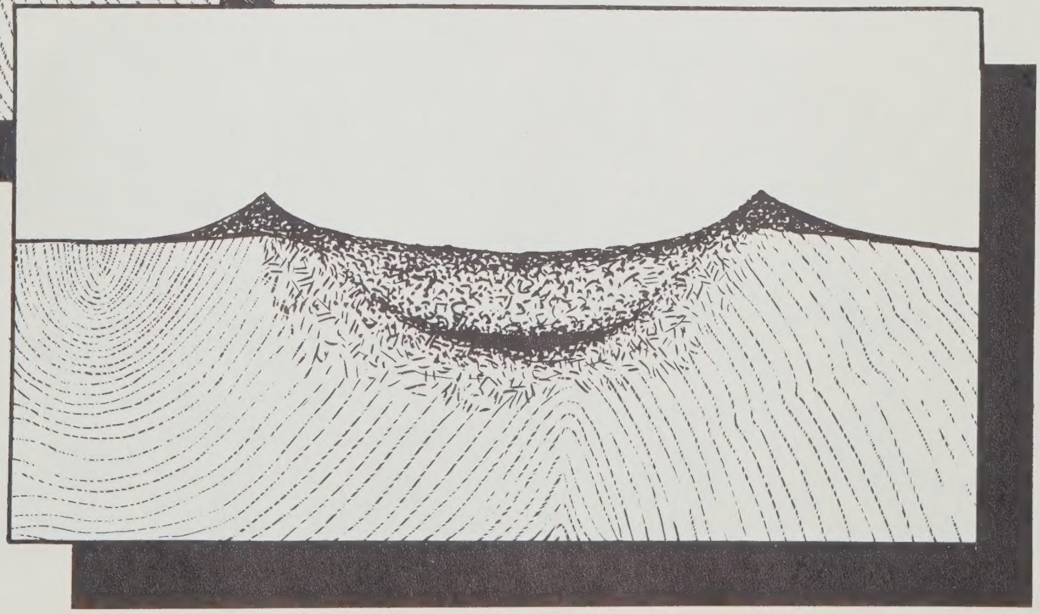
Even after the Brent Crater was gouged out, the rocks at this post were far from the surface. In fact, they were probably about 200 metres farther in from the steep, freshly created southeast wall of the crater. They are only exposed today because 450 million years of erosion, including four ice ages, have worn away the overlying rock down to their level. But even if these rocks were originally 200 metres in from the side of the crater, their broken structure and tilted attitude show how violently they were shocked by the original blast. The original solid bedrock surrounding the crater was lifted tens, if not hundreds, of metres by the stupendous shock wave radiating out from the crater blast and then they fell back, more or less into place but increasingly shattered and tilted upwards the closer they were to the crater itself.

Extensive drilling into the shattered rocks surrounding the crater, plus the dimensions of the crater itself, have enabled scientists to assess the power of the impact. What emerges from the analysis is an event of almost unbelievable devastation. In literally less than one second, more than a billion tonnes of rock were vapourized, melted, or crushed and blasted high into the atmosphere. There was then a huge hole in the earth 4 km wide, 600 metres deep, and with a rim raised up 100 metres above the pre-impact level and sloping outwards from there. The force of the explosion is estimated to have been 250 megatons (equivalent to the explosion of 250 million tons of TNT). To place this in a modern perspective, the largest thermonuclear device ever detonated by man was about 60 megatons



and a 5 megaton bomb is quite sufficient to utterly obliterate any city on earth. If the Brent Crater impact were to be repeated today, every tree in Algonquin Park to the south and every tree up to the Ottawa River, and well beyond into Quebec, would be flattened and covered with material ejected from the crater. Windows would be blown out in Ottawa, 225 km away, and the buildings would sway and crack as an earthquake, (more powerful than any observed by man in historic times) rolled under the city.

Notwithstanding the fantastic destructive energy unleashed in the Brent Crater explosion the meteorite that caused it was a rock perhaps only 150 metres in diameter. If this seems hard to believe remember that it would have hit the earth at extremely high speed. There are reasons to believe the meteorite may have hit the Earth at a speed of 20 km per second or more but even if it merely overtook the Earth in its orbit and fell to the surface (as opposed to colliding with it head on), the meteorite would still have been travelling at 11 km per second when it hit. The most advanced creatures present on earth at that time were marine crustaceans called trilobites and they had no inkling of what hit them. Even an alert human being would not have heard the Brent meteorite coming and if he had blinked he wouldn't have seen it either.



Post 3 By the Foot of the Cliff and the Edge of the Sea

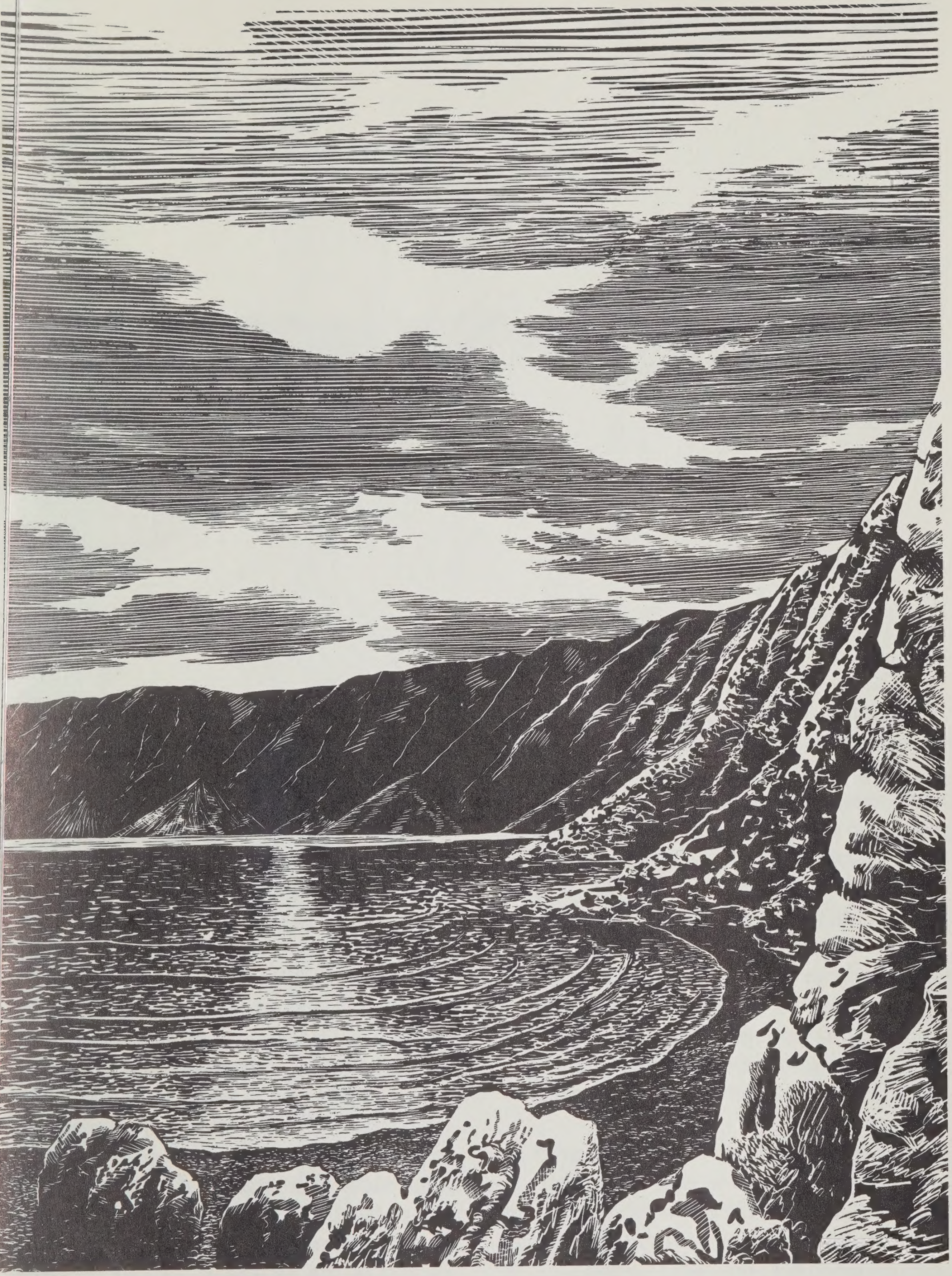
You have now reached the bottom of the crater wall — the point where it meets the present floor of the partly filled crater — and, if you are familiar with Algonquin Park, you may notice several odd things about the scene here.

For one thing, the little creek flowing down the sloping crater wall has obviously done a good job of carving out quite a deep gully — and that is very unusual because Park rocks are normally so hard that small creeks have no effect on them. For another thing, where rock is exposed on either side of the gully, you will see that it consists of individual, small, rounded rocks embedded in a matrix of softer rock — an arrangement you will never see anywhere else in the Park.

Finally, the ferns growing on the rock faces here are "bulblet bladder fern," a species common enough in the limestone areas of southern Ontario, but which, in Algonquin Park, is found only on rocks like these at the foot of the Brent Crater wall.

Obviously, something unusual has occurred here but what exactly, and what does it have to do with the crater? Geologists answer the puzzle by pointing out (both from theoretical considerations and from examples of much younger meteorite craters elsewhere in the world) that the original walls of the Brent Crater were much higher and steeper than they are now. In fact, the slope you have just descended, when fresh 450 million years ago, probably had a 45° angle and soared 250 metres above the point where you are now standing. Just as cliffs and near-cliffs do today, the original wall of the Brent Crater eroded over time, soon building up a pile of fallen rock fragments called talus which reached up the lower slopes of the crater wall. We know, too, (from evidence discussed more fully at the next stop) that the crater was partly filled with sea water early in its history, apparently to about the level you are now standing at. The sea water washed into the talus slope, slowly round-

Bulblet Bladder Ferns on lime conglomerate

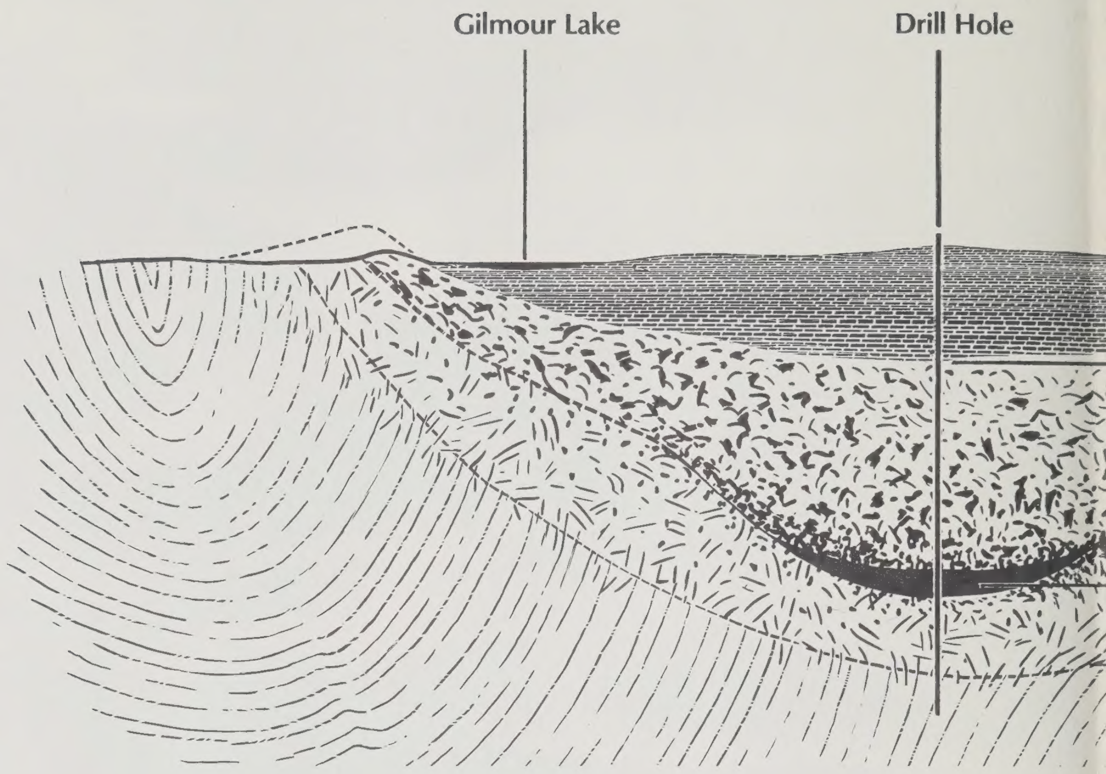


How the crater probably appeared millions of years ago

ing off the sharp edges of the talus fragments and eventually filling the spaces between the fragments with limy mud. Over time the mud solidified into gritty limestone, although still containing within it the rounded remnants of the original talus fragments.

With this sequence of events, the peculiar appearance of the rock, its softness, and the presence of limestone loving ferns all make sense. You are standing at the foot of an ancient cliff by the shore of an ancient sea.

Post 4 Buried Secrets

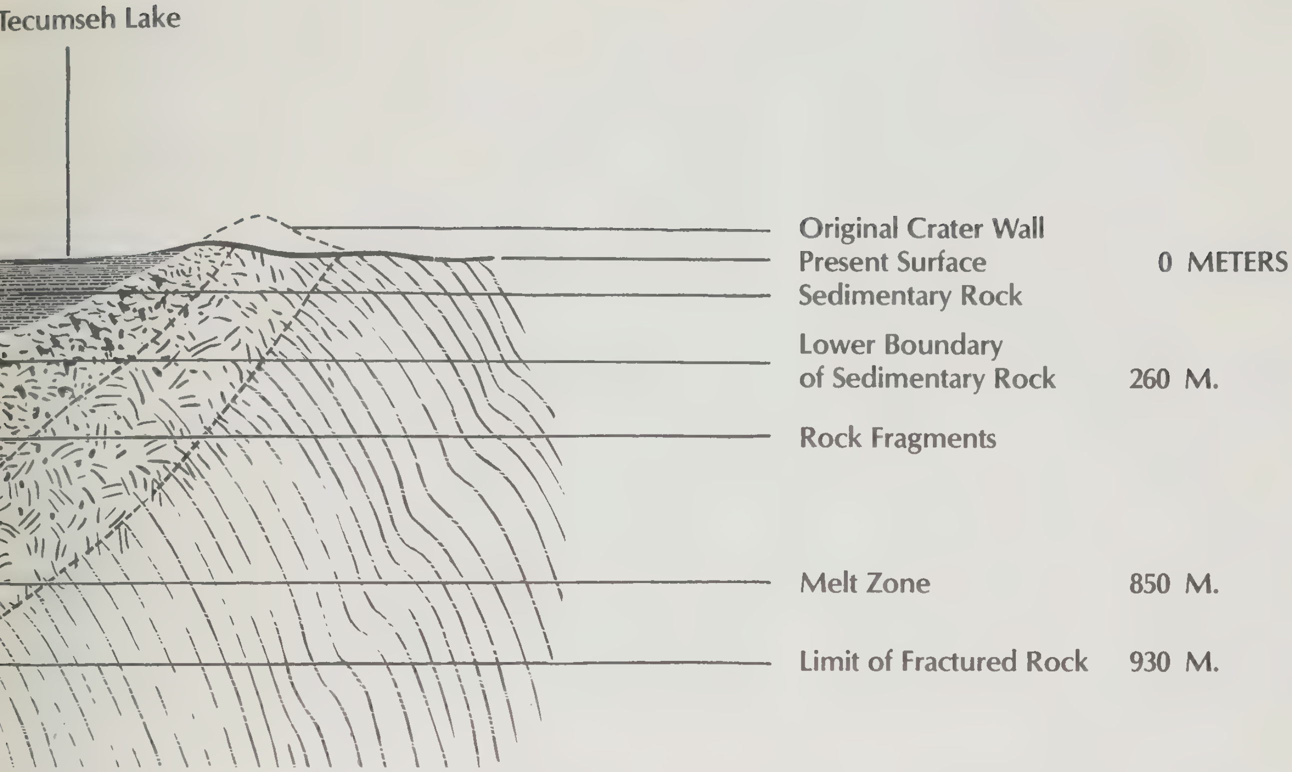


Standing as you are, at the edge of the present, basically flat crater floor and with the sloping wall behind you, you can get some sense of how the crater depression has been partly filled in over the millions of years following its initial formation. But that crude hint is about as far as it goes. In fact, if you look at the soil on the crater floor, you won't see anything that you can't find in most other places in Algonquin Park. It all looks like the usual assortment of sandy, gravelly and sometimes bouldery material carried along in the last ice sheet and left here when it melted back to the north 11,000 years ago.

The fact is, however, that the layer of glacial debris is a thin one and underneath lies more dramatic evidence of the crater's violent origin and the subsequent events leading up to today's somewhat ordinary appearance. Between 1955 and 1967, twelve diamond drill holes were sunk at various places in and beside the crater floor, hundreds of metres of drill core were brought up to the surface, and hours of painstaking analysis performed to construct a picture of the Brent Crater's buried secrets.

The hole drilled at the very centre of the crater was the most revealing and it is well worth describing what it found starting at the deepest level.

At the very bottom of the hole, 1065 metres below the surface, the rock is quite similar to that found in the surrounding parts of Algonquin Park. Starting at about 930 metres the rock starts to be cracked and shattered and this feature becomes more and more pronounced until the 850 metre level is reached. Above the 850 metre level is a 40 metre deep "pool" of once melted rock whose composition suggests that it resulted from the vapourization of the meteorite and much surrounding local rock at the instant of impact. (The 850 metre level thus represents the deepest point of excavation and compression caused by the explosion.) Above the melt zone and continuing up to the 260 metre level is a layer of jumbled, broken, local rock believed to have originated from blasted rock fragments falling back into the crater or sliding in from the sides. Many of the fragments are strongly deformed or even melted because of the impact's intense shock.



Most of the rest of the rock now filling the crater is sedimentary rock, that is rock that was laid down on the bottom of a sea that filled the crater at various times after its formation. There are ten different kinds of sedimentary rock including, at the very deepest levels, thin pans of gypsum such as are still created today in shallow salt lakes that periodically dry up in areas like the Persian Gulf. Later on, there are layers of sandstone which suggest that the crater wall breached or that the entire crater was submerged and made part of a larger sea. Limestone beds higher in the sequence are taken to mean another shallow sea which periodically covered the crater floor. It is because these rocks contain fossils of marine animals known to have lived on earth some 450 million years ago, incidentally, that scientists conclude that the crater must be at least, and probably about, that old.

Today, with the minor exception of a small cliff near Brent on Cedar Lake, the limestones and sandstones in the Brent Crater are the only sedimentary bedrock which survives in Algonquin Park. Sedimentary rock was undoubtedly found elsewhere in the Park area at one time but is now virtually all gone thanks to millions of years of erosion and glaciation. The Brent Crater rocks were exceptional, probably for two reasons. One is that, as the sedimentary layers accumulated, their weight tended to start compacting the thick layer of rock rubble underneath. Thus the bottom of the shallow lake or sea occupying the crater gradually kept sinking, the water persisted, new deposits kept being laid down, and the final accumulation of sedimentary rock probably ended up being much thicker inside the Brent Crater than it was outside. A second reason for the persistence of the sandstone and limestone layers in the crater is that, being at the bottom of a deep, saucer-shaped basin of rock, they could hardly be carried off downstream somewhere by running water. Then, when the glaciers came, the rocks were again partly protected by being "down in a hole."

What the glaciers did succeed in doing, of course, was scraping out some of the sedimentary rock and covering up almost all of the rest. Today there are a few outcrops of limestone in the extreme, southern part of the crater but otherwise there is no visible hint that so many buried secrets lie beneath the crater floor.

Post 5 An Impact Even Now

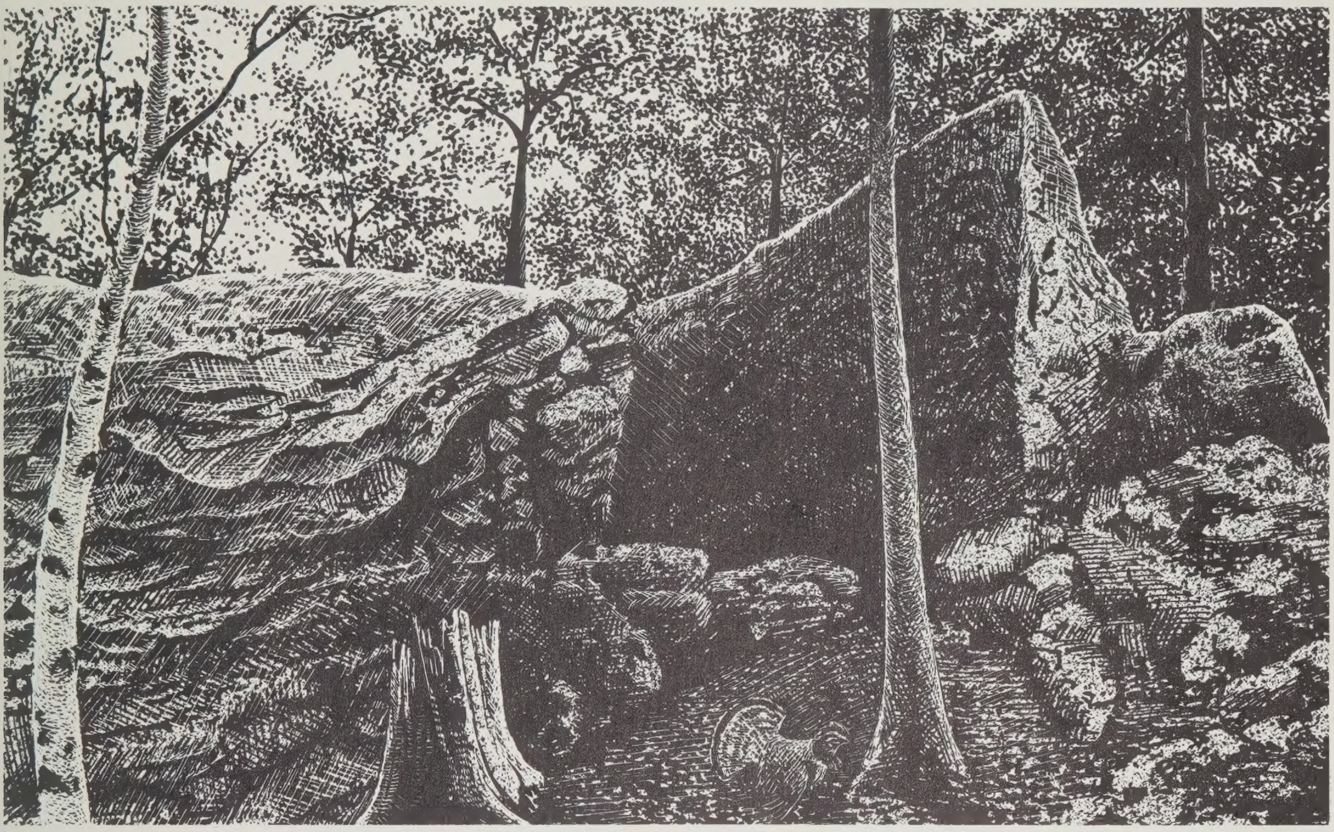
From this vantage point you can see part of Tecumseh Lake, one of the two lakes now occupying part of the crater floor. When the last glacier entered the crater over the north wall and reached the floor, it apparently spread out and gouged into the sedimentary rock along the northeastern and northwestern edges of the floor a little more deeply than elsewhere. The resultant slight depressions in the floor filled with water when the glacier finally retreated and the two lakes, Tecumseh here, and Gilmour on the other side of the crater, have persisted until today.

In their origin and present outward appearance, there is nothing at all unusual about either lake. Nevertheless, in regard to their chemistry, Tecumseh and Gilmour are real standouts in Algonquin. Of all the lakes in the Park these two have the highest concentration of bicarbonate, a substance which has a strong ability to neutralize or "buffer" acid. Most lakes in Algonquin have low amounts of bicarbonate and a correspondingly poor ability to neutralize acid rain falling into them, but this is not a problem in these two lakes. Gilmour Lake has such a high bicarbonate concentration, in fact, that it is over the level at which a lake is considered to be "totally insensitive" to acid rain, making it the only such lake in Algonquin.

You may already know why Gilmour and Tecumseh lakes are so special in this regard. Bicarbonate is derived from calcium carbonate which is limestone and Gilmour and Tecumseh, alone among Algonquin Park lakes, are lying on limestone bedrock.

The limestone, of course, with its beneficial effects on these two lakes, would not be here if it hadn't been for the crater. It is rather startling to think that, even 450 million years later, the meteorite that collided with our planet at this spot is still having an impact.

Post 6 Shattered Rock and Shattered Theory



We have been talking about the meteorite impact origin of the Brent Crater as if it were an absolute, proven fact. In reality science does not, and cannot, give such certainty, especially when it is dealing, as in this case, with events taking place hundreds of millions of years ago.

All we can really do is collect facts, think up as many plausible theoretical explanations as possible for what we observe and then try to collect more observations which will disprove some of the proposed explanations. The best we can hope for is to have one "surviving" theory that is consistent with, and not disproved by, all the facts and observations we have gathered.

In the case of the Brent Crater, the idea of a meteorite hitting the earth was the first explanation proposed as the origin of the circular structure we now see — but it wasn't the only one. Some scientists suggested that it might be a very old, extinct volcano instead. Since there were no eyewitnesses to the event, how is it that we are so sure that the meteorite theory is "correct" and the volcano theory is wrong?

There are a couple of lines of evidence. One is that if the Brent Crater were volcanic in origin, you would predict that drilling into the now partly filled up crater would reveal a deep, funnel-shaped hole in the bedrock leading up from deep in the earth. If it were a meteorite crater, on the other hand, the expected result would be a symmetrical, basin-like depression in the earth's crust. As we saw back at Post 5, drilling here in the Brent Crater revealed a picture consistent with a meteorite impact and inconsistent with an ancient volcano.

A second line of evidence has to do with the integrity of the rock surrounding the crater. Modern day volcanoes are surrounded by rocks that are penetrated by veins of cooled lava but are otherwise basically intact and little disturbed. A big meteorite striking the earth, however, can deliver more energy than a hydrogen bomb and would be expected to shock the rocks the same way, or even more than, an underground nuclear explosion does.

Detailed examination of the shattered rocks before you show that they are remarkably similar to those resulting from a nuclear blast and nothing at all like those from near a volcano.

Once again, the evidence, hundreds of millions of years old though it may be, clearly appears to shatter the volcano theory and point convincingly toward the idea of a meteorite impact.

Post 7 A Mere Piffle?

You are now back at the parking area but before you leave, why not climb the tower for a last look out over the crater? There is one more crater-related subject which merits some contemplation.

The Brent Crater before you is a very old one and it is among the most thoroughly studied in the world. Otherwise, however, it is not especially remarkable. It is only one of scores now known and it is a rather small one at that. Its real significance may be as a good example of an event which, on a few occasions, has changed the course of life on our planet.

For years scientists have puzzled over the several sudden, mass extinctions of life that have taken place during Earth's history — including the most famous of all, the disappearance 65 million years ago of all the dinosaurs and many other animals and plants then living. Many theories have been proposed but one now gathering particular support is that a really enormous meteorite (probably a stray asteroid from the asteroid belt between Mars and Jupiter) was responsible. Calculations show that an asteroid 10 km in diameter could have done the job. That may sound small but 10 km is more than the distance from sea level to the top of Mount Everest and if a "rock" that big hit the earth at the minimum, gravitationally-generated, speed of 11 km per second it would have instantaneously blasted out, not just a little pothole like the one here, but a crater fully 30 km deep and 100 km in diameter, (later enlarging to 200 km because of slumping from the sides into the centre).

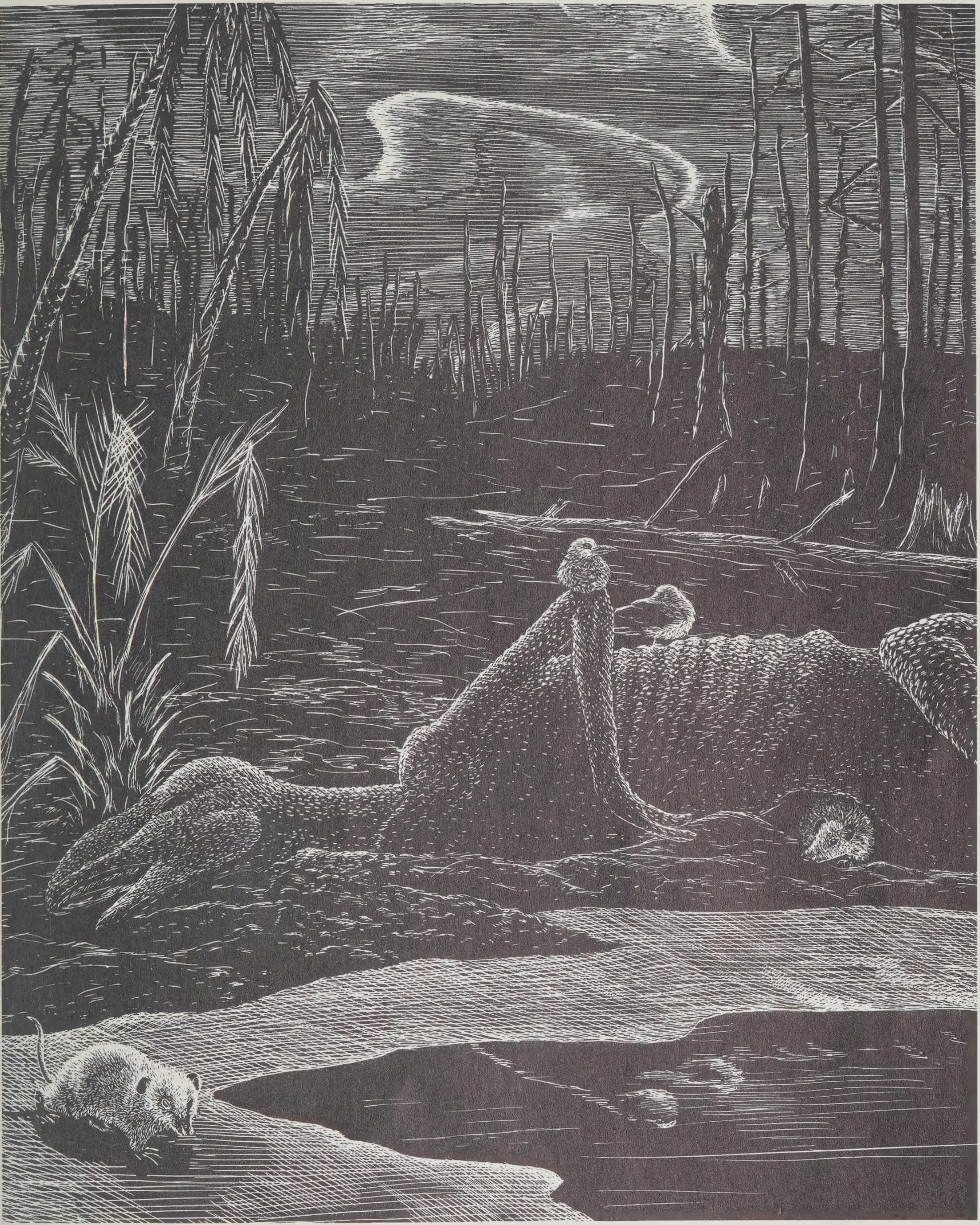
Such an apocalyptic explosion would have blown hundreds of billions of tonnes of dust into the upper atmosphere and from there the choking pall would have spread around the earth and remained airborne, blotting out the sun for months or even several years. Just as modern computer simulations predict would occur today in the event of an all-out nuclear war, the earth's temperatures, even in summer, would have plunged to below freezing. Plants would have died in the cold, dark world, dinosaurs and other animals would have frozen or starved to death and, by the time the dust settled and warm temperatures finally returned, it would have been all over for most forms of life that had held sway over the earth. Some plants would have survived as seeds or spores but the only animals that could have made it would be those that ate seeds or carcasses.

Scientists cannot point to a 65 million year old crater of the appropriate size to back up the theory but the impact might well have occurred in the sea or some other place where all traces could have been destroyed since the explosion. Besides, there is another kind of evidence which gives powerful support to the asteroid idea. In sedimentary rocks all over the world there is a thin layer of clay at the 65 million year level, precisely where the fossils of dinosaurs and other organisms of the day abruptly disappear. The special thing about this clay layer is that it is extremely rich in an element called iridium, a substance which is rare on earth but which happens to be found in high concentrations in meteorites from outer space . . .

When the dust from the asteroid impact finally settled (and formed the clay layer) the few surviving plants and animals found a world that would never be the same. The dinosaurs and other dominants were gone forever and the way was open for the survivors to evolve into new forms which could take their places. The mammals were the most successful in filling the biological voids and among the many new lines that appeared was the one that eventually gave rise to the primates, including our species, the human being.

The really interesting and important point is that if the dinosaurs had not been destroyed — if the slate had not been wiped clean, so to speak — it is very doubtful that we and other modern mammals would have evolved the way we did. The dinosaurs might very well still be here, keeping the earth's few lowly mammals very much in their shadow.

And, while it's not something we need to lose any sleep over, the possibility is there that the Earth will again be struck by an



asteroid. Over 1,000 asteroids more than 1,000 metres in diameter are now calculated to intersect the Earth's orbit. Given enough time, one of them will eventually hit the earth just as others have hit us in the past.

The damage could be really serious like that caused by the one 65 million years ago or it could be quite small, a mere "piffle" by comparison, perhaps like the one that caused the Brent Crater before you, 450 million years ago.

Post 8

We hope you have enjoyed your walk around the trail and learning something of the Brent Crater and its significance. If you do not wish to keep this guide booklet please place it in the box at this post so that others may use it later.

If you wish to keep the guide please pay at the introductory sign if you have not already done so. Thank you.

Other Algonquin Park Publications

This trail guide is only one of many publications published in cooperation with the Ministry of Natural Resources by The Friends of Algonquin Park. The Friends is a registered charitable organization with a volunteer board of directors and was established in 1983 to assist the Park with its educational and interpretive programs.

The following is a list of official Park publications published by the Friends. All are available by writing to the address below and many are on sale at the Wendigo Access Point Station and the Brent Store as well. When in the Highway 60 Region of the Park drop in at either of The Friends' bookstores (at the Park Museum and the Pioneer Logging Exhibit) where a complete selection of Algonquin-related human and natural history books, records, cassettes and posters is available.

	(1987) Price
Algonquin Provincial Park Canoe Routes	$2.50
Algonquin Provincial Park Backpacking Trails	1.50
Fishing in Algonquin Provincial Park	1.50
Birds of Algonquin Provincial Park	1.50
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Barron Canyon Trail (history of canyon)	0.35
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